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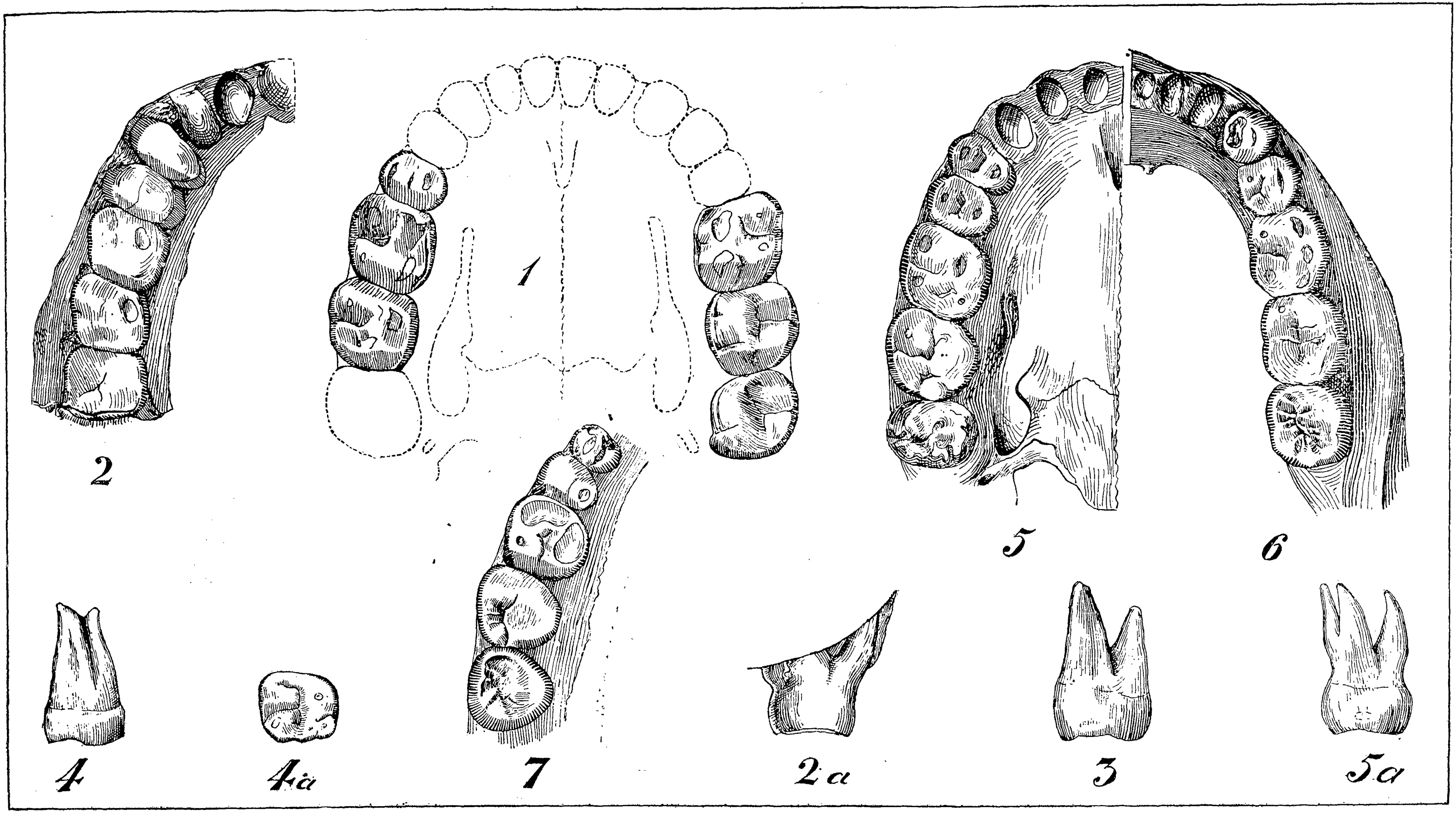
PLATE IX.



1–2. *Man and Woman of Spy.* 3. *Maori.* 4. *Tahitian.* 5–6. *Fan.* 7. *Esquimaux.*

THE

AMERICAN NATURALIST

VOL. XXVII. April, 1893. 316

THE GENEALOGY OF MAN.

BY E. D. COPE.

The ancestry of man is a question to be solved by paleontology. Within the last twenty years, important progress has been made in our knowledge of the phylogeny of the mammalia, and some points have been gained which throw considerable light on the more immediate predecessors of man. These additions to knowledge have been made in the fields of both simian and human paleontology, and they have naturally received attention from archeologists as well as paleontologists. The question must be approached from the side of anatomy primarily, although aid from any other source is essential. Philology can, of course, give us no assistance, since the first man can have left no trace of his language. It is a fact that in some quarters, archeologists who are not anatomists, seem to underrate the value of anatomy in the premises, and are inclined to dispute the existence of men of very primitive or simian physical characteristics. But archeology, apart from anatomy, is a poor guide in the field of human ancestry.

Nothing is better known than that some races of men present a larger proportion of simian characteristics than others. Thus these approximations are fewest in the Indo-European race, and are rather more evident in the Mongolian. In the Polynesian, Negro, and Bushmen, they are most numerous, and in about equal but differently distributed proportions. Confining our attention to the skeleton, it is known that almost every part of it is the seat of variations of greater or less significance.

Much importance attaches to the dentition. Many years ago, Owen[1] called attention to the fact that in the dark races the roots of the last superior molar are distinct from each other, while in the Indo-Europeans they are known to be more or less fused together. These now well-known characteristics of human dentition constitute one of the examples of transition from a simian to a human type. I have pointed out a corresponding modification in the structure of the crown of the superior true molars, viz: the transition from a quadritubercular to a tritubercular structure in passing from the lower to the higher races. As this point has some interesting implications in the earlier phylogeny of man, and as its value has been disputed, I give it a little attention.

The facts of the case are as follows: I have demonstrated[2] the fact that all forms of dentition exhibited by the Eutherian Mammals have been derived from a primitive tritubercular type. Professor Osborn says that he expects to be able to do the same for the Multituberculate (? Prototherian) dentition. I have also shown that man exhibits a tendency to revert from his primitive quadritubercular molar to this tritubercular type.[3] These facts are now common knowledge among paleontologists, although Dr. Brinton states in one of his late works that the latter proposition has been "refuted" by Dr. Harrison Allen and Professor Virchow. As to the significance of these facts, I have expressed the view that this acquisition of a tritubercular molar is a reversion to the lemurine type. This conclusion is necessary because the lemurs are the last of the families in the line of the ancestry of man which present this dentition. The monkeys and anthropoid apes are all quadritubercular, except a few limited collateral branches of the former, which still retain the lemurine type. There are also a few collateral types of lemurs which have acquired one or more quadritubercular molars, but they are not typical. In many tritubercular mammals, a precocious form or two can be found, which has acquired the fourth tubercle. But the further back we go in time, the fewer they become, until, in the Puerco fauna, of eighty-two species of Eutherian Mammals, but four have true quadritubercular superior molars.

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[1] Odontography, 1840–5, p. 454.

[2] Proceeds. Amer. Philosoph. Soc., Dec. 1883; Origin of the Fittest, 1887, pp. 245, 347, 359.

[3] Amer. Journal of Morphology, II, 1888, p. 7.

I take this opportunity of saying, however, that reversion is not necessarily a result of heredity. It may be simply a retrogression on a line of advance already laid down. What influence lemurine heredity may have had in the case of man, it is not easy to know. But it must be borne in mind that various forms of degeneracy of molar teeth are possible other than the resumption of the tritubercular type, yet the normal reduction generally presented, is just this lemurine and primitive Eutherian condition. The simplicity of the elements involved, has something, but not everything, to do with this reversion.

Dr. Paul Topinard has made an investigation[4] of the characters of the crowns of the molars in man, and has reached general conclusions identical with my own. He remarks (p. 665), " It is demonstrated, in conclusion, that the teeth of man are, at present, in process of transformation, and that in some future which is remote, the inferior molars shall certainly be quadricuspid, and the superior molars tricuspid. It will be curious to have the statistics as to prehistoric man; unfortunately, their crania are rare, and their molars generally much worn." In the details of his examination, there are some divergencies from my results. Thus he finds the quadritubercular second and third superior molar relatively of more frequent occurrence in Europeans than I did. But the absence of Europeo-Americans from his tables reduces the percentage of trituberculars in the Indo-Europeans. He makes no report of Esquimaux. Had he observed this type, he would have found a higher per cent. of tritubercular upper molars than in any race that he has recorded. He confirms my conclusion as to the high percentage of quadritubercular superior molars in the Malays, Polynesians and Melanesians.

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[4] L'Anthropologie, 1892, p. 641 (Nov., Dec.).

The relation of this fact to phylogeny is to confirm Hæckel's hypothesis of the lemurine ancestry of man. I have advanced the further hypothesis that the Anthropomorpha (which include man and the anthropoid apes) have been derived directly from the lemurs, without passing through the monkeys proper. This close association of man with the apes, is based on various considerations. One of them is that the skeleton of the anthropoid apes more nearly resembles that of man in the most important respects than it does that of the monkeys. This is especially true of the vertebral column, where the anapophyses are wanting in the Anthropomorpha (insignificant rudiments remaining on one or two vertebræ, as pointed out by Mivart), while they are well developed in the monkeys and lemurs. The frequent presence of the tritubercular molar in man disposes of the superior claim of the monkeys over the lemurs to the position of ancestor. Another significant fact pointing in the same direction is the existence of large-brained lemurs with a very anthropoid dentition (Anaptomorphidae) in our Eocene beds. This resemblance is very remarkable, much exceeding that lately observed by Ameghino in certain extinct forms of monkeys in Patagonia, which appear to be ancestors of the existing South American monkeys (Cebidae), and possibly of the Old World monkeys also. The superior molars of Anaptomorphus are tritubercular, while the premolars, canines, and incisors are essentially anthropomorphous, and rather human than simian. Anaptomorphus is probably at the same time the ancestor of the Malaysian lemurine genus Tarsius, and M. Topinard remarks that Tarsius has as good claims to be regarded as ancestral to Homo as Anaptomorphus. But M. Topinard must be aware that in the existing genus the character of the canine and incisive dentition is very unlike that of the Anaptomorphus and Homo. It is specialized in a different direction. The dentition of Anaptomorphus being so generalized as compared with Tarsius, I suspect that its skeleton will be found to present corresponding characters. Of course, if it be found hereafter to have the foot structure of Tarsius (which I do not anticipate), it must be removed from the line of ancestry of the Anthropomorpha.

It must be further observed that the ancestral line of the Anthropomorpha cannot be traced through any existing type of Lemuridae, but through the extinct forms of the Eocene period.[5] This is on account of the peculiar specialization of the inferior canines, which are incisor-like, and because of the peculiar character of the incisors themselves, in the modern lemurs in the restricted sense. But we have numerous lemurine types of the Eocene of both America and Europe which satisfy the conditions exactly, so far as the dentition is concerned. These are mostly referable to the family Adapidae.

Unfortunately, we do not know the entire skeletons of these Eocene lemurs, but as far as we have them (genera Tomitherium and Adapis), they are monkey-like. But we have what is almost as useful, the skeleton of their Eocene and Puerco ancestors, the Condylarthra. I long since pointed out that the latter order (not the genus Phenacodus, as Lydekker has represented me as saying), must be the ancestors of the lemurs, basing my views expressly on the general structure of Phenacodus, Periptychus and Meniscotherium. The structure of the ungual phalanges of Periptychus is very significant, and even more so is that in Meniscotherium, as recently shown by Marsh, who adopts (without credit) my hypothesis of lemurine affinities of the Condylarthra (which he renames the Mesodactyla). From Condylarthra back to Creodonta is an easy transition, and I have always assumed that the Creodonta were derived from generalized Polyprotodont Marsupialia. This view has been entirely confirmed by the recent discoveries of Ameghino in Patagonia, where he has found forms whose remains may be referred with equal propriety to the one group or the other. M. Topinard has been rather hasty in reaching the marsupial ancestry in supposing that Phenacodus belongs to that order. All the evidence shows that Phenacodus is a generalized ungulate placental.

To return to the more immediate ancestry of man. M. Topinard believes that I hold the opinion that the Hominidae descended directly from the lemurs without the intervention of the Simiidae. I have, on the contrary, expressed[6], and now maintain as a working hypothesis, that the Anthropomorpha were descended from the Eocene Lemuroids. In my system[7] the Anthropomorpha includes the two families Hominidae and Simiidae. The sole difference between these families is seen in the structure of the posterior foot; the Simiidae having the hallux opposable, while in the Hominidae the hallux is not opposable. This is not a strong character, since it depends on a slight difference in the form of the entocuneiform bone. In some vertebrates, as the tree frogs, the same and similar characters (genus Phyllomedusa) are not regarded as of family value. It is then highly probable that Homo is descended from some form of the Anthropomorpha now extinct, and probably unknown at present, although we do not yet know all the characters of some extinct supposed Simiidae, of which fragments only remain to us. It cannot now be determined whether man and the Simiidae were both descended from a genus with opposable hallux, or without opposable hallux, or whether from a genus presenting an intermediate character in this respect. This genus was, in any case, distinct from either of the two existing genera of Simiidae, Simia and Hylobates, since these present varied combinations of anthropoid resemblances and differences, of generic and specific value.

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[5] On the Primitive Types of the Orders of the Mammalia Educabilia, 1873, p. 8.

Professor Virchow has recently[8] thrown down the guage to the evolutionary anthropologists by asserting that "scientific anthropology begins with living races," adding "that the first step in the construction of the doctrine of transformism will be the explanation of the way the human races have been formed," etc. These two assertions are inconsistent, since the only way of solving the latter problem will be by the discovery of the ancestral races, which are extinct. The ad captandum remarks of the learned professor as to deriving an Aryan from a Negro, etc., remind one of the criticisms directed at the doctrine of evolution when it was first presented to the public, as to a horse never producing a cow, etc. It is well known to Professor Virchow that human races present greater or less approximations to the simian type in various respects. Such are the flat coössified nasal bones of the Bushmen; the quadritubercular molars of the Polynesians; the flat ilia and prognathous jaws of the Negro; the flat shin-bones of various races; the divergent hallux of some aborigines of farther India, etc. But that no nearer approximation to the simian type than these has been discovered in any race will surprise most students of the subject. Professor Virchow does not satisfactorily explain the significance of the Cannstadt and Neanderthal skulls, and in his address he ignores the important and well authenticated discovery of the man and woman of Spy. To these ancient people I will now devote some space, describing more especially the dentition so far as it has been preserved.

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[6] American Naturalist, 1885, p. 467.

[7] Origin of the Fittest, 1887, p. 346, from American Naturalist, 1885, p. 346, where the classification of the Taxeopoda should be in a foot-note; loc. cit., 1889, October.

[8] Popular Science Monthly, Jan. 1893, p. 373, translated.

What had been long suspected is now established, through the discovery and descriptions of MM. Lohest and Fraipont of

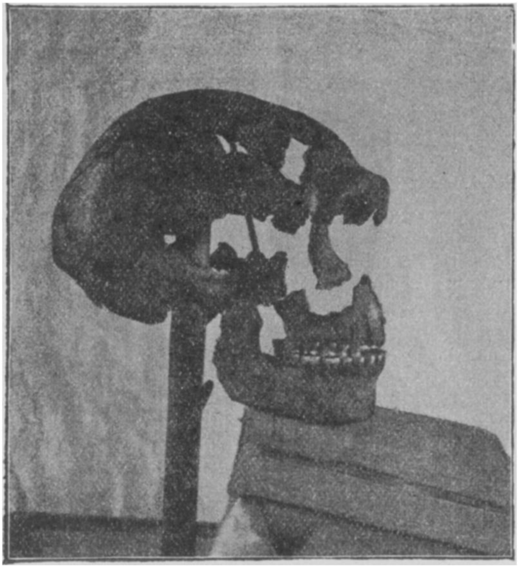

FIG. 1—SKULL OF THE MAN OF SPY. From Professor G. F. Wright's Man and the Glacial Period. From a photograph.

Liége, viz.: that there dwelt in Europe during paleolithic times, a race of men which possessed a greater number of simioid characteristics than any which has been discovered elsewhere. The important discovery in the grotto of Spy, of two skeletons, almost complete, served to unify knowledge of this race, which had previously rested on isolated fragments only. These skeletons proved what had been previously only surmised, that the skeleton of Neanderthal, the lower jaw of Naulette, and the crania of Cannstadt, belong to one and the same race. The simian characters of these parts of the skeleton are well known. These are the enormous superciliary ridges and glabella; the retreating frontal region; the thickness of the cranial wall; the massive mandibular ramus with rudimentary chin, and the large size of the posterior molars. MM. Fraipont and Lohest have added other very important characters to these, viz: the tibia shorter than in any other known human race; the sigmoid flexure of the femur; the divergent curvature of the bones of the fore-arm, and a very peculiar form of the posterior face of the mandibular symphysis. Of these characters MM. Fraipont and Lohest write as follows:[9]

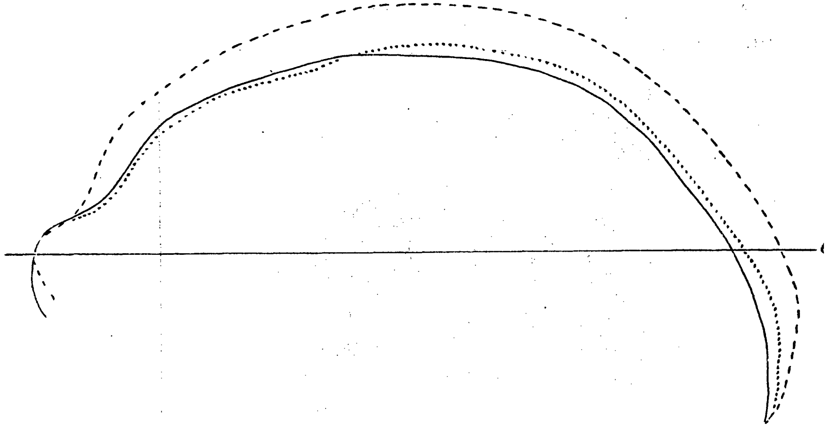

FIG. 2.—Outlines of calvaria of the Neanderthal man in solid line; of the Spy man no. 1 in dots; and of the Spy man No. 2 in broken line. From Fraipont and Lohest.

I.—The prominent superciliary crests, which are characteristic of the Cannstadt race. No existing race presents such a development, neither the Papuans, Australians, nor Negroes of any race. But we find the superciliary crests and underlying sinuses identical in adult female orangs and chimpanzees and young male gorillas. In the female chimpanzees the crests are almost inferior in size to those of the man of Spy.

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[9] Archives Belges de Biologie, VII, 1886, p. 731, Gand.

II.—The retreating forehead of the two crania of Spy, is not found in any existing human race, while it is typical of that of Cannstadt. It is characteristic of female orangs and gorillas and of the young males of both species, and of adult males and female chimpanzees. It appears in existing men in rare and isolated cases.

III.—The prominent transverse superior semicircular crest of the occipital bone is found in existing races among the Fellahs of Africa and the Nigritos. It is characteristic of the Cannstadt skulls, and presents exactly the same characters as the young male and female orang and gorilla, and young male and adult female of the chimpanzee.

IV.—No human race presents the characters of the lower jaw exhibited by those of Spy, Naulette and Shipka. In this part of their osteology the anthropoids depart widely from man, the most conspicuous point in the latter being the presence of a chin. Accordingly, the angle formed by the anterior face of

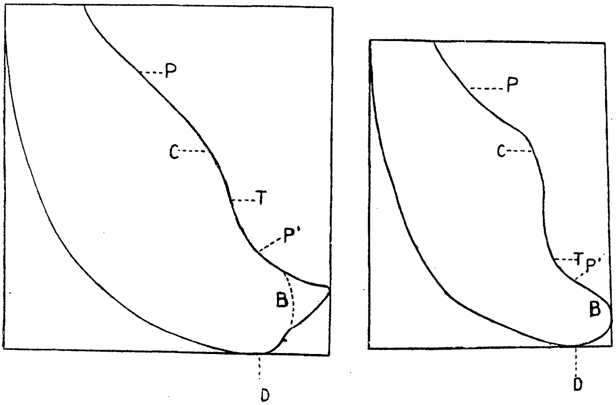

FIG. 3. FIG. 4.

Vertical sections of symphysis mandibuli of gorilla (Fig. 3), and orang (Fig. 4). From Fraipont and Lohest.

the symphysis with the inferior border of the horizontal ramus, is less than a right angle in man, and much more than a right angle in the anthropoids. According to Topinard, this angle in fifteen Parisians is 71°.4; in fifteen African Negroes, 82°.2; in fifteen Neocaledonians, 83°.9; in the jaw of Naulette, 94°. In the best preserved jaw of Spy, the angle is 107°, if measured from the inferior symphysial border, or 90° if measured from the inferior border of the ramus. There is no chin in the jaw of the Cannstadt race, and the large angle approaches without nearly equaling that of the anthropoids. But the posterior face of the symphysis presents the most remarkable peculiarity. In the symphysis of the apes (Figs. 3, 4, 5) the posterior border is a continuous slope from the alveolar border to the inferior margin, interrupted by a slight concavity below the middle. In the human jaw this line slopes backward to near the middle, where are situated the small tuberosities for the insertion of the genio-glossal muscles. (B in the accompanying figures.) The surface then slopes rapidly forward to pass into the narrow inferior border of the chin (Figs. 8, 9). In the jaws Naulette and Spy, the structure is exactly intermediate between the two, and quite different from both. It commences above with a posterior slope similar to that of the apes, exhibiting what is called by Topinard, internal prognathism, as it appears in the lower human races. The surface then descends abruptly, form-

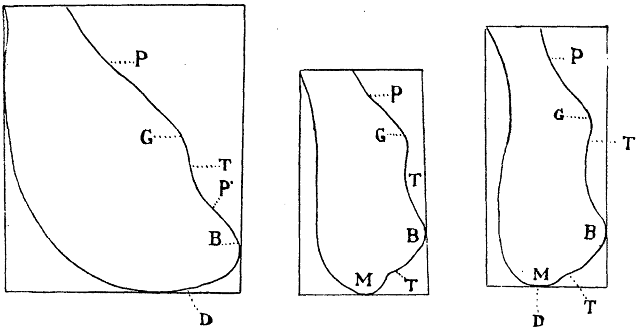

FIG. 5. FIG. 6. FIG. 7.

Vertical sections of symphysis mandibuli of chimpanzee (Fig. 5); of Spy man No. 1 (Fig. 6), and Spy man No. 2. (Fig. 7). From Fraipont and Lohest.

ing a vertical concavity, which is bounded a considerable distance below by another protuberance, the insertion of the genio-glossal muscles. This concavity is not present in the human symphysis, while it is less developed in the simian. The surface then slopes forward, as in the human symphysis, but this portion is shorter than in human jaws generally. It is represented by a convex face in the simian jaw. This character taken in connection with the others cited, goes a long way toward justifying the separation of the Cannstadt race as a distant species, as has been done by some author under the name of *Homo neanderthalensis* (Figs. 6, 7).

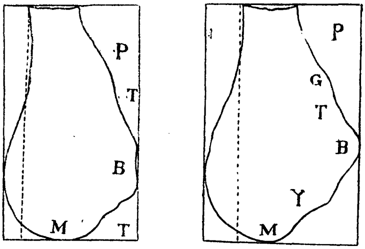

FIG. 8. FIG. 9.

Sections of symphysis mandibuli of modern Liegois (Fig. 8), and of an ancient Parisian (Fig. 9). From Fraipont and Lohest.

V.—The curvature of the ulna and radius, which produces a wide interosseous space, is not found in any human race, but is common to the apes. On the contrary, the shortness of these bones is entirely human.

VI.—The anterior convexity of the femur, with its round section, is only found among living races among the Nigritos of the Philippine Islands. It is seen in a less degree in femora of neolithic men, and occasional instances are seen among existing Europeans. It is the normal condition in the apes.

VII.—The tibia is shorter in its relation to the femur than in any human race, and is more robust than in most of them. This character, with the oval section, while not identical with what is seen in the apes, forms an approximation to it.

VIII.—The condyles of the femur are not only wider than in human races generally, but they are more produced posteriorly. The portion habitually resting on the head of the tibia is so far posterior as to throw the femur backward when in place. This requires that in order to maintain equilibrium, the head and body must have been thrown forward. This relation of the femur and tibia is what we find in the apes, and it is highly probable that the man of Spy presented a somewhat similar figure when walking. That is, the knees were bent and the body thrown forward. In the best preserved leg, the knee was also slightly bent inward. The femur had, however, the superior length generally characteristic of man, though this, it is well known, is a variable character.

MM. Fraipont and Lohest have pointed out the general characters of the dentition of the man of Spy. They show that the molars increase in size posteriorly to the same extent that they do in the apes, which is the reverse of what is usual in man, where they diminish posteriorly, or, in a few lower races (Australians, etc.), remain equal. They show that the superior molars are all quadritubercular, and that the internal root is distinct in all of them. Through the kindness of M. Lohest, I received casts and photographs of these teeth, and I give here figures the former (Plate IX), which are more satisfactory than those in the memoir from which I have already quoted so fully, where, indeed, the grinding faces are not represented at all. I also make some remarks which they suggest, on some details not noticed by MM. Fraipont and Lohest.

The casts of the teeth of the man are those of P. m. ^{2} and M. $\frac{1\,2}{}$ of one side, and of M. $\frac{1\,2\,3}{}$ of the other side. Those of the woman are alveoli of I. $\frac{2}{}$ and C. $\frac{1}{}$, and the entire teeth of P. m. $\frac{1\,2}{}$ and M. $\frac{1\,2\,3}{}$ all of one, the right, side. The crowns of the man's teeth are moderately worn, so that their composition can be studied, while those of the woman are more worn, so that the composition is somewhat obscure. Comprehensively, it may be stated that the true molars are fully quadritubercular, as in the lowest known races of men, and that the hypocone is in the anterior molars, as large as the protocone, while it is always smaller in man when present. In the female the last superior molar has a well-developed internal root, which diverges widely from the posterior external, even more widely than in a chimpanzee in my possession. This arrangement is even more simian than that seen in Australian and Maori dentitions in my collection. The last molar of the male is stated to have similar structure, but the roots cannot be clearly seen in the plaster cast. These two characters then place the man of Spy in the lowest category, just as would be naturally expected in the presence of the other simian characters already referred to. The dentition is inferior to that of the neolithic man of France,[10] where the last molar at least is tritubercular.

Some other peculiarities of these dental series may be now referred to. In the female dentition, where alone the canine alveoli remain, the size of the latter tooth and that of the premolar is large, relatively, to that of the true molars. The canine is not remarkably large, but exceeded by a little, that commonly seen in Polynesians and Australians, where it is largest among human races. The premolars exceed a little the proportions seen in the same races, approximating but not quite equaling the relative dimensions seen in the chimpanzee. The roots are relatively more robust in the transverse direction than in human dentitions generally. The first and second molars of the female are of equal transverse diameters, while the third is a little wider transversely and quite as wide anteroposteriorly. This large dimension for the third molar exceeds anything I have observed in human dentitions except in the case of a single Australian in my collection, surpassing a little that of the chimpanzee, and reminding one of some of the gibbons (Hylobates), where, however, the crown is subcircular in outline. In the male the transverse diameter of the third molar is a little smaller than that of the other molars, but the tooth is larger than is usual in man, and equals in its dimensions that of the chimpanzee.

A peculiarity which is pronounced in the male, and observable in the first molar only of the female, is the prolonged posterior convexity of the grinding surface. This is unlike anything I have seen in human molars, and resembles the character of the orang[11] more than that of any other quadrumane known to me. This appearance is increased by a contraction of the grinding surface posteriorly, by the convergence of the internal and external borders, a peculiarity apparently unique to the man of Spy. The forward overlap of inferior molars on the superior is much greater than usual in the male. This contraction of the posterior part of the external border is equally marked in the female, but the posterior border is not so convex. It results from the peculiar form of the external borders of the crowns of the true molars in both sexes, that they form an echelon arrangement. This does not seem to be an adaptation to an oblique outline of the maxillary arch, which is broadly rounded as in the Australians and Polynesians.

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[10] Cope loc. cit., p. 17.

[11] Owen Odontography, p. 444.

Summarizing the above observations, I would say that in the quadritubercular molars, with distinct and divergent roots, the man of Spy takes the lowest position among the subspecies of man. Second, that in the relative proportions of the premolars and molars with each other and among themselves, he possesses some characters lower than any of the known races of man, and approximates near to the apes. Third, that in the echelon arrangement of the external wall of the molars, he presents a peculiarity more strongly pronounced than either man or apes, and whose true significance can not now be determined. It occurs in the abnormal V-shaped maxillary arch of existing men, but the arch in the man of Spy has not this character, but is fully rounded, and as it occurs in both sexes, it is not probably an abnormality.

In conclusion, it may be observed that we have in the *Homo neanderthalensis* a greater number of simian characteristics than exist in any of the known races of the *Homo sapiens*, although, so far as known, he belongs to the genus Homo. The posterior foot, so far as preserved, indicates this to be the case. The foot-character, which distinguishes the genera Homo and and Simia still remains. There is still, to use the language of Fraipont and Lohest, "an abyss" between the man of Spy and the highest ape; though, from a zoological point of view, it is not a wide one.

The flints which were discovered in the stratum of cave deposit containing the human remains, are of the paleolithic type known as Mousterien in France, which are of later origin than the Chelléen or older paleolithic. The older paleolithic man is not yet known. It is interesting to observe that these flints (Mousterien) are of the same form as the obsidian implements which I collected at Fossil Lake, in Oregon, with the bones of extinct llamas, horses, elephants, sloth, etc. The animals which accompanied the man of Spy are, *Cœlodonta antiquitatis* (wooly rhinoceros), *Equus caballus*, *Cervus elaphus*, *Cervus tarandus*, *Bos primigenius*, *Elephas primigenius*, *Ursus spelæus*, *Meles taxus*, *Hyaena spelæa;* five extinct and four existing species.

As the evidence now stands, the most primitive and simian of human races inhabited Europe. No trace of the *Homo neanderthalensis* has been found in any other region of the earth. As, however, paleolithic implements are found in all continents, we may anticipate that this or some similar species of man will be discovered there also. An equally probable conclusion is that, taking into consideration the characters of the Neolithic man, the Europeans originated in Europe, and that some of us are the direct descendants of the *Homo neanderthalensis*.

EXPLANATION OF PLATE.

Dentition of the man and woman of Spy, natural size; taken from casts.

Fig. 1. Superior molars of the man from below.

Fig. 2. Do. of the woman from below; 2a do. last posterior molar from behind.

Fig. 3. Maori, last superior molar from behind.

Fig. 4. Do. of Tahitian from below; *a* do. from behind, showing fused roots.

Fig. 5. Superior dentition of a Fan from West Africa, from the collection of the University of Pennsylvania; *a* last superior molar.

Fig. 6. Inferior dentition of Fan of Fig. 5.

Fig. 7. Esquimaux, superior molars; from cranium in Army Med. Museum, Washington, D. C.